

J251784B

(12) UK Patent Application (19) GB (11) 2 279 796 (13) A

(43) Date of A Publication 11.01.1995

(21) Application No 9313317.1

(22) Date of Filing 28.06.1993

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(51) INT CL<sup>6</sup>

G07D 1/00

(52) UK CL (Edition N )

G4X X5

(56) Documents Cited

GB 2122010 A GB 1430099 A GB 1375390 A

(58) Field of Search

UK CL (Edition L ) G4V VAG , G4X X5 X6

INT CL<sup>5</sup> G07D 1/00 1/02 1/04 1/06

(54) Cash handling apparatus

(57) A method of checking the acceptability of value carriers (ie coins or banknotes) in automatic machines that both accept and return such value carriers consists of carrying out the check according to two acceptance criteria. The first defines the conditions for the acceptance of a value carrier ie falling in range  $T_A$ , the second, more rigorous, criterion defines the conditions for the re-use of a value carrier ie falling in range  $T_B$ . The value carriers that are not to be re-used are conveyed by transport means to one-way stores, those that are available to be re-used are conveyed by transport means to two-way stores. The value carriers that are not accepted are transported directly back to the dispensing opening.

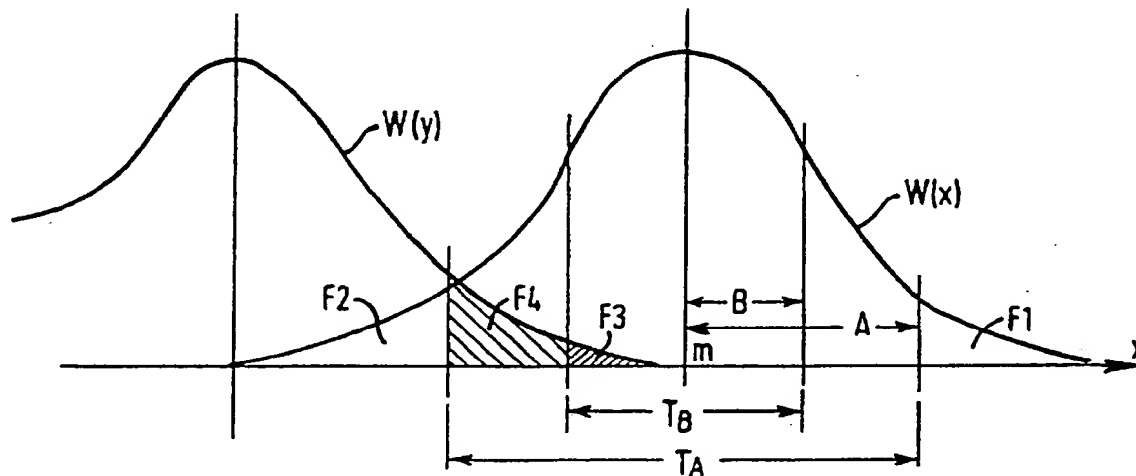


FIG. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

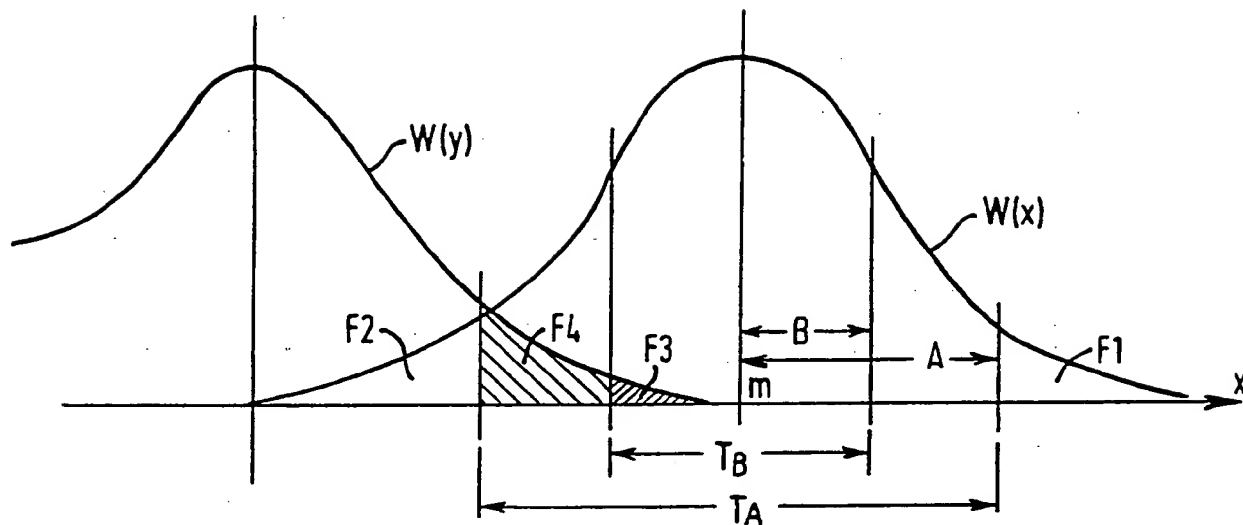


FIG. 1

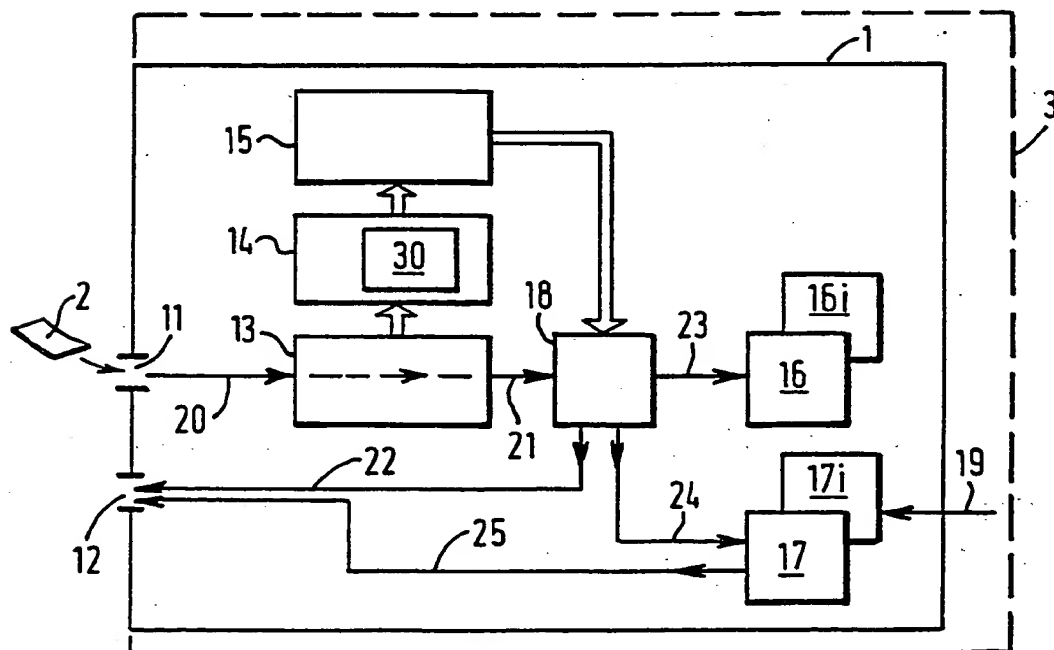


FIG. 2

## VALIDATING VALUE CARRIERS

The invention relates to a method and apparatus for validating value carriers, such as banknotes, coins or tokens.

5           The method of the present invention can be applied where value carriers are to be accepted from one person by an automatic machine, such as an automatic teller machine or a vending machine, and passed on to another person. In the following, the  
10 description is restricted to use with banknotes, that is to say, where automatic machines accept banknotes in payment and dispense accepted banknotes as money returned, for example, either as change in vending machines or payphones or as banknotes of lower  
15 denomination or of a different currency in banknote-changing machines. Thus "dispensing" as used in this specification is intended to be construed accordingly, as opposed to the return of a value carrier which is deemed by a machine not to be valid. Furthermore, the  
20 term "valid" could, for example, imply that a credit value is established or incremented in respect of the value carrier presented.

Automatic machines that allow banknotes that have been paid in to be re-used, that is to say put into  
25 circulation again as dispensed money, are already

known, for example, from U.S. Patent 5,076,441. In such automatic machines, the "acceptability", that is, for example, the authenticity, and frequently, in addition, the general condition of the banknotes offered to the automatic machine are also checked. This is done by comparing one or more measurements that can be made of the banknote with corresponding given reference values or tolerance ranges which are normally stored in the automatic machine. The choice of parameters which are measured depends primarily upon the recognition characteristics existing on the banknote. A pre-requisite for this, of course, is that "acceptable" and non-"acceptable" notes can be statistically differentiated by measuring techniques, that is to say that at least the expected values of the measured parameters are different.

If the measurement or measurements of a banknote do not fall within the given tolerance ranges, it is concluded that the banknote is not acceptable, that is to say either is not genuine or is not in a good condition. It is therefore rejected by the automatic machine. Conversely, if the measurement or measurements lie within the tolerance ranges, it is concluded that the banknote is acceptable, that is to say is genuine and in a good condition. It is therefore accepted by the automatic machine in payment

for a return service, is stored and is available for re-use, if required, in the form of dispensed money. Such a checking method is subject to two opposing requirements: on the one hand, when checking whether  
5 the banknote offered for payment is acceptable, the risk of a "good" banknote being rejected is to be restricted to a minimum. This is achieved, in an automatic machine that is in itself adjusted correctly, fundamentally by making the acceptance  
10 criterion broader. On the other hand, the accepted banknote which is available to the automatic machine as money for change purposes is, with the greatest possible reliability, to be actually "acceptable", that is to say genuine and in a good condition.  
15 Although the percentage of "bad" banknotes accepted with a given acceptance criterion naturally depends upon how the "bad" banknotes differ from the "good", it is nevertheless clear that making the acceptance criterion broader basically increases the probability  
20 of a "bad" banknote being accepted by the automatic machine. The second requirement, therefore, corresponds to the opposite requirement that the acceptance criterion be made narrower.

In practice, therefore, a compromise is made in  
25 which the tolerance value or values are chosen such that both the probability of an acceptable banknote

being rejected and the probability of a non-acceptable banknote being re-used are kept within limits. In known automatic machines, an acceptance rate of, for example, 95-99 % is chosen, that is to say 95-99 % of all "good" banknotes checked by the automatic machine are accepted. Thus, the probability of a "bad" banknote being accepted and subsequently re-used can normally be kept sufficiently small, such as below 1%.

In accordance with the present invention there is provided a method of, and apparatus for, accepting, validating and dispensing value carriers, wherein a value carrier presented by a user is validated according to first and second criteria, and accepted as valid if either criterion is met, with only those value carriers meeting both criteria being dispensed.

In the preferred embodiments, validation is carried out according to the first criterion in such a manner that as few genuine banknotes as possible are rejected and, according to the second criterion, in such a manner that, of the banknotes accepted and stored according to the first criterion, as far as possible all banknotes that may not be genuine are retained in the automatic machine.

Preferred embodiments of the invention are described below with reference to the drawings, in which:

Figure 1 shows a probability distribution of a measuring parameter for "good" banknotes with two acceptance criteria and a probability distribution for "bad" banknotes; and

5        Figure 2 is a diagrammatic view of the device for validating banknotes.

Figure 1 shows, by way of example, the probability distribution  $W(x)$  for a measuring parameter  $x$  with a mean value  $m$ . The measurement in question is one with which non-acceptable banknotes have parameter values  $y$  that have a probability distribution  $W(y)$  that is changed by comparison with  $x$ .

15        The given tolerance values  $A$  and  $B$  define the two acceptance ranges  $T_A$  and  $T_B$ : if, for the measured parameter value  $x$ , the absolute value of  $(x-m)$  is less than  $A$ , the banknote is regarded as acceptable. The probability of a genuine note being rejected is given by the area  $F1+F2$ . The probability of a non-acceptable banknote being accepted is given by the area  $F3+F4$ . Of the notes accepted there are then selected for re-use, in a second decision, only those banknotes in which the absolute value of  $(x-m)$  does not exceed the value  $B$ . This measure further increases the probability that only genuine banknotes will be re-used: the area  $F3$  corresponds to the

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probability of a counterfeit note being regarded as genuine and re-used. The area F4 corresponds to those banknotes which, although accepted by the automatic machine, are no longer assigned for re-use.

5           In the normal case, several measuring parameters  $x_1, x_2, \dots, x_n$  are measured and compared with acceptance ranges  $T_{A1}, T_{A2}, \dots, T_{An}$  and  $T_{B1}, T_{B2}, \dots, T_{Bn}$  ( $B_i < A_i$ ), the acceptance range  $T_{Ai}$  having a mean value  $m_i$  and a maximum deviation of  $A_i > 0$ , i.e.

10                            $T_{Ai} = [m_i - A_i, m_i + A_i]$

and the acceptance range  $T_{Bi}$  has the same mean value  $m_i$  and a maximum deviation of  $B_i > 0$  (where  $A_i > B_i$ ), i.e.

$$T_{Bi} = [m_i - B_i, m_i + B_i],$$

the first acceptance criterion consisting in that, for

15            $x_i$  in  $T_{Ai}$  for all  $i, i=1, \dots, n$ ,

the banknote is accepted, and the second acceptance criterion consisting in that, for

$x_i$  in  $T_{Bi}$  for all  $i, i=1, \dots, n$ ,

the banknote is assigned for re-use.

20           The characteristic values  $\{m_i\}$ ,  $\{A_i\}$  and  $\{B_i\}$  are stored in a data store 30 of the decision unit 14.

          One possible measuring parameter  $x_i$  is the dimension, that is to say the length, width or thickness of the banknote. Another advantageous  
25           measuring parameter  $x_i$  is the spectrum of the light reflected or transmitted by the banknote, as described



in DE-A-2 924 605. One or more predetermined parts of the banknote may be measured. A further measuring parameter  $\xi$  that can be used is the change produced in a magnetic field by a banknote provided with magnetic printing ink, as described in US-A-4 864 238.

The measurements  $\{\xi_i\}$  are compared with acceptance ranges  $\{T_{Ai}\}$  and  $\{T_{Bi}\}$  stored in the decision unit 14. Preferably, the initial acceptance ranges  $\{T_{Ai}\}$  are determined offline with the aid of a representative amount of acceptable banknotes, are stored in the data store 30 of the decision unit 14 and are adapted in the course of time to the changes in the measuring apparatus and to the characteristics of the banknotes in circulation (see, for example, GB-A-2 059 129).

The method can also be applied to automatic machines that accept different types of banknote  $w_1, w_2, \dots, w_n$  and dispense them again. The method is in that case preceded by a first step in which first the type of banknote  $w_i$  is determined. In most countries, this can be done on the basis of identifying the dimensions of the notes; it may, however, be the case that this test is not sufficiently reliable or even possible, such as, for example, in the case of U.S. notes which all have the same dimensions.

Figure 2 shows the diagrammatic arrangement of a

device 1 according to the invention. It has at least one acceptance opening 11 and at least one dispensing opening 12 for accepting and returning value carriers, and further consists of a measuring unit 13, a decision unit 14 with data store 30, a control unit 15, at least one one-way store 16, 16i and at least one two-way store 17, 17i. These units are connected by transport means 20, 21, 22, 23, 24, 25 and a common routing element 18.

After a value carrier 2 has been inserted into the acceptance opening 11 it is taken by a first transport means 20 to the measuring unit 13 which contains the measuring apparatus required for checking acceptability. The parameter measurements determined there are passed to the decision unit 14 which compares them with the tolerance ranges stored in the data store 30 and decides whether the value carrier is acceptable and, if so, whether it can be assigned for re-use. The control unit 15 is instructed to control the common routing element 18 of the transport system accordingly: upon leaving the measuring unit 13

- a non-acceptable value carrier is transported directly back to the dispensing opening 12,
- an acceptable value carrier that is not to be re-used is directed by the routing element 18 onto transport means 23 and is transported to one of

several one-way stores 16, 16i,

- an acceptable value carrier that is to be available for re-use is directed by the routing element 18 onto transport means 24 and is taken to one of several two-way stores 17, 17i and stored.

The two-way stores 17, 17i can be controlled by the automatic machine 3 via control means 19 to supply the desired type and number of value carriers 2 to the dispensing opening 12 via transport means 25.

The acceptability test is carried out in detail as follows: after the banknote 2 has been inserted into the measuring unit 13 the  $n$  scheduled measurements  $x_1, x_2, \dots, x_n$  are determined and passed on to the decision unit 14 where it is established whether the measurement  $x_i$  falls within the range  $T_{Ai}$  for all  $i$ . If that is not the case, the banknote is returned to the user by the automatic machine at the dispensing opening 12. If  $x_i$  is within  $T_{Ai}$  and also within  $T_{Bi}$ , for all  $i, i=1, \dots, n$ , the banknote is conveyed to one of the two-way stores 17, 17i from whence it is available for re-use as money returned. If that is not the case, that is, while  $x_i$  is within  $T_{Ai}$  it is not within  $T_{Bi}$  for all  $i, i=1, \dots, n$ , the banknote is deposited in one of the one-way stores 16, 16i where it remains until the automatic machine 3 is emptied.

Although, in the preferred embodiments, two separate storage devices are provided for each type of value carrier, it would be possible to provide a single storage device wherein the position of the value carrier within that storage device is known. In this case, the value carriers would be dispensed selectively so that only those which meet both acceptance criteria are dispensed, while retaining those value carriers which meet only one of the acceptance criteria.

Alternatively, all value carriers accepted by the machine according to the first criterion K1 could be stored in a single storage device and a subsequent validation performed according to the second criterion K2 on value carriers leaving the storage device. Such value carriers would either be returned to the user or retained within the automatic machine in dependence on whether or not the second criterion K2 is met.

Furthermore, although separate acceptance and dispensing openings have been described, it is possible to provide a single opening for performing both functions.

## CLAIMS

1. A method of accepting, validating and dispensing value carriers, wherein a value carrier presented by a user is validated according to first and second criteria, and accepted as valid if either  
5 criterion is met, with only those value carriers meeting both criteria being dispensed.

2. A method as claimed in claim 1, wherein all accepted value carriers are stored in a single storage  
10 means, the position within said storage means being known and used selectively to dispense said value carriers.

3. A method as claimed in claim 1, wherein all accepted value carriers are stored in a single storage  
15 means, and wherein a subsequent validation is performed according to the second criterion on value carriers leaving the storage means.

4. A method of checking value carriers in automatic machines which accept value carriers in  
20 payment comprising storing them in at least first and second storage means, and, when instructed by a control unit, returning them to a user of the automatic machine, wherein, before acceptance and

storage, the value carriers are checked for acceptability according to a first acceptance criterion, wherein the method further comprises checking the value carriers with a second acceptance criterion which is more rigorous than the first, storing the value carriers that satisfy only the first acceptance criterion in said first storage means and storing the value carriers that satisfy both acceptance criteria in said second storage means, the value carriers stored in said second storage means being available to be re-dispensed to a user.

5. A method according to claim 4, wherein characteristic values of the first acceptance criterion are determined on the basis of measurements performed on a representative number of acceptable value carriers and are stored in the automatic machine before being put into service.

6. A method according to claim 5, wherein the stored characteristic values of the acceptance criteria are adapted during service to compensate for changes in the measuring apparatus and changes in the characteristics of the value carriers in circulation.

7. Method according to any one of claims 4 to

6, wherein the first acceptance criterion consists of an AND-combination of one or more acceptance ranges  $T_{Ai}$  with a mean value  $m_i$  and a maximum deviation of  $A_i > 0$ , i.e.

5 
$$T_{Ai} = [m_i - A_i, m_i + A_i],$$

and the second acceptance criterion K2 consists of an AND-combination of one or more acceptance ranges  $T_{Bi}$  with the same mean value  $m_i$  and a maximum deviation of  $B_i > 0$ , where  $A_i > B_i$ , i.e.

10 
$$T_{Bi} = [m_i - B_i, m_i + B_i],$$

and the characteristic values  $\{m_i\}$ ,  $\{A_i\}$  and  $\{B_i\}$  are stored in a data store of a decision unit.

8. A method according to claim 7, wherein a change in the measuring apparatus is detected by periodically measuring a fixed reference value and is corrected by adapting the mean values  $\{m_i\}$  stored in the data store.

15

9. A method according to claim 7 or claim 8, wherein a change in the characteristics of the value carriers in circulation is compensated for by adapting the mean values  $\{m_i\}$  stored in the data store according to the parameter values measured in the accepted value carriers.

20

10. A method according to any one of claims 1 to 9, wherein the value carriers belong to various types  $w_1, w_2, \dots, w_n$  the method further comprising identifying the type of value carrier  $w_i$ , the type-specific characteristic values of the acceptance ranges being stored, and the accepted value carriers being stored in separate, type-specific first and second storage means.

11. A method as claimed in any preceding claim, wherein if the value carriers do not satisfy said first acceptance criterion, they are returned directly to a dispensing opening.

12. Apparatus for accepting, validating and dispensing value carriers, the apparatus comprising means for validating a value carrier presented by a user according to first and second criteria and accepting said value carriers as valid if either criterion is met but dispensing only those value carriers meeting both criteria.

13. Apparatus for accepting and returning value carriers comprising means defining at least one opening for accepting and/or dispensing a value carrier, a measuring unit, a decision unit for



deciding whether a value carrier presented by a user meets first and second acceptance criteria, first and second storage means for the value carriers and a transport system arranged to transport value carriers from the opening means to the measuring unit, from the measuring unit to one of the opening means, said first storage means and second storage means, in dependence on the output of the decision means and from the second storage means back to the opening means, the arrangement being such that only those value carriers meeting the first criterion are stored in the first and second storage means and only those value carriers meeting both criteria are stored in the second storage means.

14. Apparatus according to claim 13, wherein, from the outlet of the measuring unit and via a routing element, the transport system is arranged to

- transport a non-acceptable value carrier directly back to the opening,
- direct an acceptable value carrier that is not to be re-used to the first storage means, and
- direct an acceptable value carrier that is to be available for re-use to said second storage means.

15. Apparatus according to claim 13 or 14,

further comprising a data store for storing the characteristic values of the acceptance criteria.

16. Apparatus according to claim 15, arranged to accept and return a plurality of types of value carrier, the measurements in the measuring unit serving also to identify the type of value carrier, the type-specific characteristic values of the acceptance criteria being stored in the data store and the accepted value carriers being stored in separate, type-specific first or second storage means.

**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

Application number

GB 9313317.1

**Relevant Technical fields**

(i) UK CI (Edition L ) G4X (X5 X6) G4V (VAG)  
(ii) Int CI (Edition 5 ) G07D 1/00 1/02 1/04 1/06

**Search Examiner**

G NICHOLLS

**Databases (see over)**

(i) UK Patent Office

(ii)

**Date of Search**

17 AUGUST 1993

Documents considered relevant following a search in respect of claims 1-16

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2122010 A (TOKYO SHIBAURA DENKI). see page 5 lines 24-122 especially lines 63-65, and page 7 lines 6 to 188 especially lines 95-118	1, 3, 11, 12
X	GB 1430099 (S.F.A) whole document especially page 1 lines 77-82	1, 12
X	GB 1375390 (MITSUBISHI) whole document - see especially page 1 lines 36-40	1, 4, 11 12

Category	Identity of document and relevant passages -18-	Relevant to claim(s)

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